



Bharatiya Vidya Bhavan's
SARDAR PATEL COLLEGE OF ENGINEERING
(Government Aided Autonomous Institute under Mumbai University)
Andheri (W) Mumbai - 400058



COURSE CONTENTS

(S.Y. B.Tech. in Mechanical Engineering)

Academic Year: 2022-23

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BS-BTM301 Laplace Fourier Complex Linear Algebra
Course Pre-requisites: - BS-BT101, BS-BT201

Course Objectives:

The main objectives of the course are

1. To learn Laplace & Inverse Laplace transforms and its application to solve differential equations.
2. To understand concept of Fourier series, its complex form and enhance problem solving skills.
3. To understand concept of complex variables and conformal mapping.
4. To learn various matrices, operations and important theorems.

Course Outcomes:

At the end of the course the students shall be able to

1. Solve problems based on Laplace and inverse Laplace transform. Apply theory of Laplace transforms to evaluate real integrals and solve initial & boundary value problems.
2. Solve problem based on Fourier series expansion.
3. Solve complex variable problems.
4. Find rank of matrices, Eigen values and Eigen vectors of matrices

Course Content

Module	Details	Hrs
1	Laplace Transforms Function of bounded variation (Statement only) Laplace Transforms of $1, e^{at}, \sin at, \cos at, \sinh at, \cosh at, t^n, \operatorname{erf}(\sqrt{t}), J_0(t)$, Shifting theorems, change of scale, $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}, L\left\{\int_0^t f(u)du\right\}$ Convolution theorem, Evaluation of real integrals using Laplace transforms.	07
2	Inverse Laplace Transforms Evaluation of Inverse Laplace Transforms using partial fractions, convolution theorem, shifting theorems and other properties. Application of Laplace Transform to solve initial & boundary value problems involving ordinary differential equation with one dependent variables	06
3	Fourier Series & Integrals Orthogonal & Orthonormal set of functions. Fourier series, Determination of Fourier constants, Dirichlet's conditions Fourier series for $f(x), x \in [c, c+2\pi]$ and $x \in [c, c+2L]$	05
4	Fourier Series half range & complex form. Fourier series of Odd and Even functions Half range Fourier Sine & Cosine series, Parseval's Identity Complex form of Fourier series	05
5	Complex Variables & Mapping Functions of complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian and polar coordinates. Harmonic functions, Analytic method and Milne Thomson methods to find $f(z)$, orthogonal trajectories.	07

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	Conformal mapping, Bilinear transformation, cross ratio, fixed points	
6	Matrices Orthogonal, Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian & Unitary matrices and their elementary properties. Elementary operations and their use in getting the Rank, Normal form of a matrix, PAQ form, Consistency of system of linear homogeneous and non-homogeneous equations.	06
7	Eigen values & Cayley Hamilton Eigen-values and Eigenvectors of a matrix, Cayley- Hamilton theorem, Function of a matrix, Diagonalization of a matrix	06

Text Books: -

1. B S Grewal (2014), "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, ISBN 8174091955, 1315 Pages

Reference Books: -

1. Erwin Kreyszig (2010), "Advanced Engineering Mathematics" Wiley Eastern Limited, Singapore 10th edition, ISBN 8126554231, 1148 Pages.
2. N.P.Bali (2017), Text book of Engineering Mathematics, Laxmi Publications, 9th edition, ISBN:978-81-318-0832-0

Sr. No.	Examination	Module
1	T – I	1 , 2 and part of 3
2	T – II	Remaining part of 3, 4 and part of module 5
3	Final exam	1 to 7

***A total of 10 tutorials to be taken batch wise covering the entire syllabus.**

PC-BTM302 Strength of Materials

Course Pre-requisites: - ES-BT104, ES-BT204

Course Objectives:

1. To determine the internal forces developed in structural members.
2. To determine the stresses and strains produced in the structural members and machine components and their deformations under various types of loads.
3. To understand analytical methods for determining the strength, stiffness and stability of various load carrying structural members and machine components
4. To study the failure theories

Course Outcomes:

Upon successful completion of the course, students should be able

1. To apply principles of engineering mechanics, science and mathematics to derive equations governing the internal resistance forces in machine components subjected to different types of loading.
2. To identify, formulate and solve for stresses and strains produced in basic components of mechanical engineering systems.
3. To discuss different experimental methods and to analyze and interpret data obtained from the experiments related to strength of materials.
4. To evaluate effect of combined in mechanical components using principal stress computations.

Course Contents:

Module No.	Details	Hrs
01	Introduction <ul style="list-style-type: none"> ○ Definitions of stress and strain, axial tensile and compressive stresses, shear stress and strain. ○ Definitions of Hooke's law, elastic limit, modulus of elasticity, yield stress, ultimate stress, modulus of rigidity, bulk modulus, Poisson's ratio, factor of safety, Volumetric strain for tri-axial loading. ○ Experimental methods such as tensile test, hardness test, impact test, etc. 	4
02	Simple deformations under axial loading <ul style="list-style-type: none"> ○ Deformation of stepped bars, tapering bars, deformation due to self-weight Thermal stresses: <ul style="list-style-type: none"> ○ Calculation of thermal stresses in structural components 	6
03	Shear Force and Bending Moment in beams: <ul style="list-style-type: none"> ○ Shear force and bending moment diagrams for statically determinate beams including beams with internal Hinges for different types of loading ○ Relationship between rate of loading, shear force and bending moment. 	6
04	Bending stresses in beams: <ul style="list-style-type: none"> ○ Classical flexural formula for straight beams ○ Bending stress distribution for different sections ○ Beams of uniform strength. Shear stresses in beams: <ul style="list-style-type: none"> ○ Distribution of shear stress across commonly used plane sections ○ Shear connectors Shear stresses due to torsion: <ul style="list-style-type: none"> ○ Stress and deflection during torsion of circular shafts – solid, hollow and 	9

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	stepped ○ deflection of shafts fixed at both ends ○ stresses and deflection of helical springs	
05	Principle stresses: ○ General equations for transformation of stress ○ Principal planes and principal stresses, maximum shear stress ○ Mohr's circle	6
06	Deflection of beams: ○ Deflection of beams using double integration and Macaulay's method ○ Maxwell's reciprocal theorem	5
07	Thin cylindrical and spherical shells: ○ Stress and strain in thin cylinders and spheres due to internal pressure Buckling of columns: ○ Euler's theory of columns	6

Text Books:

1. Junnarkar, S. B., and H. J. Shah. *Mechanics of structures (Vol. I)*, Charotar Pub. House, Anand (1995).
2. Beer, Ferdinand P., R. Johnston, J. Dewolf, and D. Mazurek. "Mechanics of Materials, McGraw-Hill." (2006).
3. S. S. Rattan, *Strength of Materials, Tata McGraw-Hill.* (2017).

Reference Books:

1. Gere, James M., and S. P. Timoshenko. "Mechanics of materials Brooks." Cole, Pacific Grove, CA (2001): 815-39.
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-BTM305 Thermodynamics

Pre-requisites: Applied Physics- I and II, Applied Chemistry- I and II, Engineering Mathematics- I and II

Course Objectives:

The objectives of this course are:

1. To explain the fundamental concepts and principles of Classical Thermodynamics.
2. To explain the Laws of Thermodynamics and illustrate its applications to practical Non-Reactive Thermal Systems.
3. To explain fundamental principles and operation of thermodynamic cycles viz: Vapor Power Cycles, Gas Power Cycles and Refrigeration Cycles and illustrate its applications to engineering systems.
4. To explain the principles and the Laws of Thermodynamics for Reactive Systems and illustrate its applications to Reactive Thermal Systems involving Combustion.

Course Outcomes:

Upon successful completion of this course, the students should be able

1. To understand, exemplify and apply the fundamental concepts and principles of Classical Thermodynamics for analysis of practical Non-Reactive Thermal Systems and evaluate their thermodynamic properties and energy interactions.
2. To understand, exemplify and apply the Laws of Thermodynamics to various thermal systems for evaluation of thermodynamic properties, energy interactions and performance parameters.
3. To understand the fundamental principles and operation of practical thermodynamic cycles viz: Vapor Power Cycles, Gas Power Cycles and Refrigeration Cycles, and apply the principles to evaluate, interpret and compare performance parameters of these cycles used in Steam Power Plants, I.C. Engines, Gas Turbines and Jet Propulsion, and Refrigeration.
4. To understand the fundamental concepts and the Laws of Thermodynamics for Reactive Systems and apply it for analysis of practical Reactive Thermal Systems involving process of Combustion.

Course Contents:		
Module No.	Details	Hrs.
1.	Fundamental Concepts: Macroscopic Vs. Microscopic approach, Thermodynamic system, surrounding and universe, Control Volume, Thermodynamic State, Properties, Process and Cycle, Thermodynamic Equilibrium, Quasi-Static process, Work Transfer and Heat Transfer.	05
2.	First Law of Thermodynamics: Non-flow System undergoing a Cycle and Change of State, Concepts of Energy, Internal Energy, Enthalpy, Specific heats, Latent heats, PMM-I, Steady Flow process, Steady Flow Energy Equation (SFEE), and its applications to various devices such as boilers, nozzles and diffusers, turbines and engines, compressors and pumps, throttling device,	06

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	condensers and heat exchangers etc, Zeroth Law of Thermodynamics, IPTS	
3.	Second Law of Thermodynamics: Limitations of First Law of Thermodynamics, Cyclic Heat Engine, Energy Reservoirs, Kelvin-Planck and Clausius' statements and their equivalence, Refrigerator and Heat Pump, Simple Vapor Compression Refrigeration cycle, Reversibility and Irreversibility, Causes of Irreversibility, Carnot Cycle, Reversed Heat Engine, Carnot Theorem, Absolute Thermodynamic Temperature Scale.	06
4.	Entropy: Clausius' Theorem, The Inequality of Clausius, Entropy - a Property, Entropy changes in an irreversible process, Principle of Entropy, Entropy and Direction, Entropy and Disorder, Available Energy of a Cycle, Law of Degradation of Energy, Reversible Work and Availability in a Non-flow and Steady Flow Process, Useful Work, Dead State, Irreversibility.	06
5.	Vapor Power Cycles: Properties of Pure Substances, p-v, T-s and h-s Diagrams, Dryness Fraction, Use of Steam Tables and Mollier Diagram, Ideal and actual Rankine Cycle, Reheat Cycle, Ideal and actual Regenerative Cycle, Reheat-Regenerative Cycle, Efficiencies in Steam Power Plant.	07
6.	Gas Power Cycles: Air Standard Cycles for I.C. Engines: Otto Cycle, Diesel Cycle and Dual Cycle, Efficiency and performance parameters, Comparison of performance parameters, Air Standard Cycles of Gas Turbines: Joule Cycle, Brayton Cycle, Efficiency and performance parameters, Modified Brayton cycle with Intercooling, Reheating and Regeneration, Jet Propulsion Cycle.	07
7.	Thermodynamics of Reactive Systems: Degree of Reaction, Reaction Equilibrium, Law of Mass Action, Heat of Reaction, Gibbs' Function Change, Heat Capacity of Reacting Gases in Equilibrium, Combustion Thermodynamics: Adiabatic Flame Temperature, Enthalpy and Internal Energy of Combustion, Third Law of Thermodynamics, Second Law Analysis of Reactive Systems.	05

Term work:

1. At least one assignment on each module comprising theoretical concepts and numerical examples. Application of Excel / MATLAB for numerical examples.
2. Participation in activities such as industry expert lecture/ industry visit etc. organized by faculty for providing the wider exposure to students.
3. Technical presentations / Case study on course contents with industry applications
4. At least one MCQ Test based on course contents of GATE Examination.

Assessment: Attendance: 5 Marks, Assignments: 10 Marks, Viva-voce/ MCQ Test: 10 Marks.

Term Activity with Industry 4.0 Approach:

1. Industry visit to Thermal Power Plant / Industry of repute.
2. Lectures / seminar by experts from thermal industry / plant / R & D organization.
3. Internship (one to two weeks duration) in a thermal industry/ plant of repute.

4. Case study on course contents and recent developments applicable to industry / plants applications viz. operation of power plants, waste heat recovery, cycle efficiency etc

Text Books :

1. Nag, P.K., *Engineering Thermodynamics*, 5th edn, Tata McGraw Hill, New Delhi, 2013.
2. Cengel, Yunus A., and Boles, Michael A., *Thermodynamics An Engineering Approach*, 8th edn, McGraw Hill, New York, 2014.
3. Holman, J.P., *Thermodynamics*, McGraw Hill, New York, 1987.

Reference Books :

1. Achuthan, M., *Engineering Thermodynamics*, Prentice Hall India Pvt., Limited, 2004.
2. Saad, Michel A., *Thermodynamics for Engineers- Principles and Practice*, 1997.
3. Eastop, T. D., and A. McConkey, *Applied Thermodynamics for Engineering Technologists*, 1996
4. Sonntag, Richard Edwin, Claus Borgnakke, Gordon John Van Wylen, and Steve Van Wyk. *Fundamentals of Thermodynamics*. Vol. 6. New York: Wiley, 1998.

Recommended NPTEL/ IITBombayX Lectures / Courses:

1. Thermodynamics IITBombayX Course by Prof. U.N. Gaitonde, IIT Bombay
<https://www.iitbombayx.in/courses/thermodynamics-5>
2. Thermodynamics Video Lectures by Prof. U.N. Gaitonde, IIT Bombay [Online]
3. Basic Thermodynamics NPTEL Course Lectures by Prof. S.K. Som, IIT Kharagpur
<https://nptel.ac.in/courses/112/105/112105123/>

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-BTM306 Manufacturing Science

Course Pre-requisites: - BS-BT105, BS-BT106, BS-BT205, BS-BT206

Course Objectives:

The objective of this course is to:

- To impart understanding and appreciation of breadth and depth of the field of manufacturing.
- To impart basic concept, process parameters & capabilities of manufacturing processes like, Casting, plastic moulding and metal surface treatment.
- To impart knowledge of parts and working of various machines like, Lathe, Milling, Drilling, Surface Grinding & Shaper, and the tools used in these machines. Also to add knowledge of use of Jigs and fixtures.
- To learn and apply the concepts of machining for particular component, by deciding sequence of operations and concerned machine tool requirement for same
- To make the students aware of the basic welding processes and their specific method of application. To learn and apply the concepts of non conventional manufacturing processes for products of different design and material

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Student will broaden the knowledge and perspective of the manufacturing world in which many of the students will contribute their talents and leadership
2. Student will be able to decide/select the manufacturing processes and jigs and fixture, which they have learned to manufacture any new product
3. Students will be conversant with the unconventional machining processes, basic welding, molding and metal surface treatment processes and will be able to identify the process needed and its limitation
4. Student will be able to explain construction & working principles of machines like Lathe, Milling, drilling etc. & their application.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	Pattern making and Foundry: Materials used for pattern making, Types of pattern, allowance Pattern, core box, core prints and cores. Plastic molding: Compression molding, Injection molding, Blow molding, Transfer molding, shell molding, carbon dioxide molding Casting: Gravity die or permanent mold casting, pressure die casting, cold chamber die casting, centrifugal casting, , investment mold casting, Plaster mold casting, continuous casting. Metal surface treatment: Electroplating, galvanizing, anodizing, metal spraying, Solidification Science in Casting.	06
2	Lathes: type of lathes, their construction and working, operation of lathes, attachments and accessories used on lathe, type of tools, cutting speed, feed, depth of cut and machining time. Capstan and turret lathes, tooling for simple jobs. NC, CNC and DNC machines, machining centers and types.	06

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3	Milling Machines: types of machines, horizontal, universal, vertical, Cutters and their applications, Operation on milling machines, Use of dividing head and circular table. Direct, simple, compound, differential and angular indexing Table feed in milling. Work holding devices.	06
4	Drilling Machines: Types of machines, Types of drillings, operations such as drilling, boring, reaming, spot facing, counter boring, counter sinking and tapping. Drill speeds and feeds. Planer machines, shaping machines and slotting machine: Various types, construction and working of machine, operations and tools, field of application, quick return mechanism feed mechanisms of these machines	05
5	Design of Jigs and Fixtures, Introduction, need, Definitions, Principles of location, types of locators, Principles of Clamping, Types of clamping, Jig Bushes and types of Jig Bushes, Indexing devices, Fool proofing means, Types of Jigs and fixtures, Box Jig, Milling fixtures, etc., Design principles for Jigs and fixtures, Design of Jigs and Fixtures	06
6	Grinding: Grinding machines such as pedestal, cylindrical surface, centre less and tool and cutter grinder. Operations on the above mentioned machines. Grinding wheel, selection and specifications. Dressing and trimming of grinding wheels. Finishing operations such as lapping and honing. Green Manufacturing	05
7	Welding: Riveting, soldering and brazing, fusion welding, gas and arc welding, submerged arc welding-inert gas welding, electro slag welding, thermit welding, welding equipment, Pressure welding – Solid phase welding, resistance and friction welding- other miscellaneous welding processes, weld joint types, weldability. Non-Conventional Machining Processes: Abrasive jet machining, Electric discharge machining, Electron beam machining, Plasma arc machining, Ultrasonic machining, Additive Manufacturing etc.	08

Recommended Books:

Text Books:

1. S. Kalpakjian & S.R. Schmid, “Manufacturing Engineering and Technology, fourth edition”, PEARSON
2. O.P. Khanna, “A Textbook of Production Technology”, Dhanpat Rai Publications
3. Dr. P.C. Sharma, “*Production Technology*”, S Chand and Co.
4. M. Lal and O P Khanna, “*Textbook of Foundary Technology*”, S Chand and Co.

Reference Books:

1. G. Boothroyd & W.A. Knight, “*Fundamental of Machining and Machine Tools*”, third edition”, CRC.
2. Milton C. Shaw, “*Metal Cutting Principles*”, OXFORD University Press
3. W. A. J. Chapman, “*Workshop Technology- Part I, II and III*”, Edward Arnold
4. S K & A K Hajra Choudhary, “*Workshop Technology, Vol. I, II*”, Media promoters and publishers Pvt. Limited, 2007
5. L E Doyle, “*Manufacturing Processes & materials for Engineers*”, Prentice Hall
6. Cyril Donaldson, “*Tool Design*”, Tata McGraw Hill, 2012

Recommended websites:

- www.nptel.ac.in
- www.swayam.gov.in

Term work:

1. One assignment on each module of the syllabus.
2. Industrial visit report (format should be provided by teacher)
3. Seminar presentation on the topic related to any one of the topics [Desirable: inclusion of video of the manufacturing process of any product]
4. Tutorial in every instructional week.
5. One Guest lecture by industry expert.
6. MCQ based on topics mentioned in latest GATE syllabus

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

HS-BTM307 Organizational Communication and Interpersonal Skills

Course Pre-requisites: - HSM-BT107

Course Objectives:

- 01** To enhance effective corporate communication through professional writing
- 02** To prepare students for successful career that meets the corporate, industrial and global requirement.
- 03** To enable students to communicate in professional environment and social context with knowledge of professional etiquette, and understand social responsibilities with multi- disciplinary approach, in all tasks of life.
- 04** To discern and develop effective organizational writing.
- 05** To inculcate in students professional and ethical attitude at the workplace and develop an ability to imbibe effective interpersonal skills

Course Outcome statements and Module –wise mapping

Co No.	Statements	Module No.
1.	Develop professional communication using precise language and formats	01, 04
2.	Apply the traits of a suitable candidate for a job/ higher education, through training and participation in group discussions, facing interviews and writing resume/ SOP	02,05
3.	Demonstrate awareness of corporate etiquette and knowledge of professional responsibilities	03
4.	Design technical documents using precise and objective language, apt for organizational communication	04, 01
5.	Deliver formal presentations effectively and develop life skills/ interpersonal skills to progress professionally by building stronger relationships in the society	02, 05,03

No.	Real Life Application Mapping with the Course
1	Communication Skills are critical career skills as well as life skills. A student can learn to be a responsible communicator, especially in the professional context.
2	The student will inculcate effective Reading and Writing skills, Speaking and Listening Skills. He or she will be equipped to express ideas in an effective manner and will learn interpersonal skills.
3	The student can use (fiction and non-fiction), magazines, videos, online articles to gain exposure to current affairs and corporate communication
4	Knowledge of good writing skills can help in the verbal section in aptitude tests, GRE, GMAT, CAT, TOEFL
5	In real life situations, students can learn to effectively communicate in various social and professional situations, and develop new perspectives. He or she can learn to participate and contribute to technical and non-technical discussions

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Course Content:

Module No.	Details	Hrs.
01	Business writing: <ul style="list-style-type: none"> Types of meetings, Notice, Agenda, Minutes of the meetings, Strategies for conducting effective meetings. Email writing: (Netiquette) 	04
02	Employment Skills: <ul style="list-style-type: none"> Group Discussion SWOT Analysis Resume Writing / Curriculum Vitae Interview Skills Statement of Purpose 	09
03	Introduction to Corporate Etiquette and Core Values: <ul style="list-style-type: none"> Etiquettes and rules of behavior Professional Conduct, Etiquette in Meetings Dining Etiquettes. Core Values of an organization 	03
04	Report writing: <ul style="list-style-type: none"> Objectives of report writing, Language and style in a report, Types of reports. Formats of reports: Memo, Letter, and Project report Survey based. (<i>A Computer- aided presentation of the Project report</i>) Proposal Writing: <ul style="list-style-type: none"> Format and style. Technical Proposals: Objectives of technical proposals, Parts of proposals. 	08
05	Interpersonal Communication and Soft Skills: <ul style="list-style-type: none"> Creating and delivering effective presentations Working and communication in teams Leadership skills Time management Conflict resolution and negotiation skills 	06

List of Assignments:

- Meeting documentation: Role play and written assignment
- Practical sessions on Group Discussion topics
- Mock Interviews, Job application and resume writing.
- Etiquettes case study and role play. MCQ's
- Three assignments on report-writing (A Bound report to be submitted on topic given in partial fulfillment of the syllabus report writing, Report content will be graded and counted during presentation, a printed copy of the presentation and a soft copy in the form of CD to be attached with the report).
- Technical Proposal (Group activity, document of the proposals)

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7. Interpersonal Skills: Case Studies, Group Activity and assignments
8. Presentations and seminar on module no. 4, 5 with Power point
9. Role play and videos taken by students.

Distribution of Term Work/ Practical marks shall be as follows: (total 50 marks).

1. Project report presentation: **10 marks**
2. Presentations on Interpersonal topics: **05 Marks**
3. Group Discussion: **05 marks**
4. Mock Interviews: **05**

➤ List of Text Books

Sr. No	Text Book Titles	Author/s	Publisher	Ed.	Module Nos.
1	Report Writing for Business	Lesiker and Petit	Mc Graw Hill	10	1
2	Technical Writing for Professional Communication	Huckin and Olsen	Mc Graw Hill	2	1, 2
3	Personal development for Life and Work	Wallace and Masters	Thomson Learning	12	3,4,5,6
4	Effective Business Communication	Herta Murphy	Mc Graw Hill	7	1,2,3, 4,6
5	Organizational Behaviour	Fred Luthans	Mc Graw Hill	12	3,5
6	Business Correspondence and Report Writing	R.C. Sharma and Krishna Mohan	Tata McGraw Hill	2	1,2,4,6
7	Soft skills	Dr. K.Alex	S. Chand and company	3	3,5,6
8	Professional Ethics	R. Subramaniam	OUP		5
9	Organizational Behaviour	Robbins Stephens	Pearson Education	12	3

➤ List of Reference Books

Sr. No	Reference Book Titles	Author/s	Publisher	Ed.	Module Nos.
1	How to Speak Fluently	Jones	IPH	1	6
2	Speaking English Effectively	Krishna Mohan N.P. Singh	Macmillan	2	6
3	“Business Communication - Concepts Cases and Applications”	Chaturvedi and Chaturdevi	Pearson	2	5
4	“Communication Skills for Engineers”	Sunita Mishra and C. Murlikrishna	Pearson	1	6
5	Business Communication- “Building Critical Skills”	Kitty O Locker	McGraw Hill	3	3, 4
6	“Body Language”,	Alan Pease	Manjul Publications	18	3, 4,6
7	“The Craft of Business Letter Writing”	Monipally	Tata McGraw Hill	1st	6
8	Soft Skills and Professional Communication	Francis Peter	Tata McGraw Hill	1st	3, 6

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9	50 ways to improve your Business English	Ken Taylor	Summertown Publishing	1st	1, 5
10	50 ways to improve your Presentation Skills in English	Bob Dignen	Summertown Publishing	1st	6

➤ **List of E - Books**

Sr. No	E- Book Titles	Author/s	Publisher	Ed.	Module Nos.
1	Business Communication Today	Courtland L Bovee	Pretince Hall	--	3, 5, 6
2	Excellence in Business Communication	John Thill	Pretince Hall	6	4,
3	Business Communication: Building Critical Skills	Kitty O Locker	Mc Graw Hill	--	3

Examinations:

Sr. No.	Examination	Module
1	T – I	01, 2
2	T – II	3, 5
3	Final Examination	1, 2, 3, 4, 5

PC-BTM352 Strength of Materials Laboratory

Course Pre-requisites: - PC-BTM302

Course Objectives:

1. To acquire ability to set up an experiment.
2. To record and analyze data from experiments.
3. To correlate experiment results against theoretical predictions
4. To discuss significance of material testing techniques

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Explain underlying principle of the experiment and outline experimental procedure and describe the parts of the experimental setup
2. Accurately record experimental observations and examine correctness of experimental readings
3. Analyze and interpret data obtained through the experiment
4. Prove compliance of experimental data with theory and justify in case results do not comply with theory and/or standard values

List of Experiments to be conducted is as follows.

1. Tension test on mild steel bar (stress- strain behavior, modulus determination)
2. Tension Test on tor-steel
3. Test on cast iron (transverse, tension)
4. Shear test on mild steel, cast iron, brass
5. Torsion test on mild steel bar/cast iron bar
6. Brinell hardness test
7. Rockwell hardness test
8. Izod impact test/Charpy test
9. Flexural test on beam (central point load) *
10. Flexural test on beam (two-point load) *

* For experiment no. 9 and 10, plot load deflection curve and find value of Young's modulus.

List of experiments from Virtual Laboratories (<http://vlab.co.in/>):

1. Basic Engineering Mechanics and Strength of Materials lab (<http://eerc01-iiith.vlabs.ac.in/index.php>)
2. Strength-of-Materials lab (<http://sm-nitk.vlabs.ac.in>)

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. MCQ based on topics mentioned in latest GATE syllabus
4. Oral Examination

PC-BTM399 Machine Shop Practice

Course Pre-requisites: -

Course Objectives:

In this course the students will:

1. Learn different safety precautions to be taken during manufacturing processes.
2. Learn to interpret job drawings, plan and execute manufacturing processes and operations to produce basic components from raw material.

Course Outcomes:

Upon successful completion of the course the student will be able to:

1. **Know** different safety precautions to be taken during manufacturing processes.
2. **Interpret** job drawings, **plan** and **execute** processes and operations to produce basic components from raw material.

Course Contents:

Job No.	Details	Hrs.
01	One job on lathe machine involving plain turning, facing, precision turning, grooving, centre drilling, external threading and taper turning	10
02	One job on shaper involving machining of horizontal and inclined surfaces.	04
03	One job on welding exercise to make a composite joint such as T-Joint.	04
04	One job on forging of parting tool	04
05	One job on forging of cutting tools used on lathes such as boring tool	04

Reference Books:

1. W. A. J. Chapman, “*Workshop Technology- Part I, II and III*”, Edward Arnold.
2. G. Boothroyd & W.A. Knight, “*Fundamental of Machining and Machine Tools*, third edition”, CRC.
3. S K & A K Hajra Choudhary, “*Workshop Technology, Vol. I, II*”, Media promoters and publishers pvt. Limited, 2007.

MC-BTM002 Indian Traditional Knowledge

Course Pre-requisites: - Mandatory course

Course Objective:

The objectives of this course are:

1. To impart knowledge about the Indian tradition, Fundamental unity, Human values, Indian traditional knowledge systems and scriptures.
2. To impart knowledge about the Indian traditional health care and medical practices, technologies, engineering and architecture in ancient India, scientific, technological developments and contributions of ancient Indian sages and scholars.
3. To impart knowledge about the Indian tradition of arts, music and dance, linguistics, significant literature and epics.
4. To impart knowledge about the ancient Indian philosophy, its scientific, social and logical perspectives and relevance in modern times.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To understand the Indian tradition, Fundamental unity, Indian traditional knowledge systems and scriptures.
2. To understand the Indian traditional health care and medical practices, technologies, engineering and architecture in ancient India, scientific, technological developments and contributions of ancient Indian sages and scholars.
3. To understand the Indian tradition of arts, music and dance, linguistics, significant literature and epics.
4. To understand the ancient Indian philosophy, its scientific, social and logical perspectives and relevance in modern times.

Course Contents:

Sr. No.	Description	Duration (hrs.)
1	Indian Tradition: Introduction to Indian tradition, Fundamental unity of India, India's role in world civilization. The Indian way of life: Scientific outlook and Indian values.	06
2	Basic structure of Indian Knowledge System: Exposure to Indian Traditional Scriptures, Vedas (Rigveda, Yajurveda, Atharvaveda and Samaveda), Upvedas (Ayurveda, Dhanurveda, Gandharvaveda, Sthapatya), Vedangas (Shiksha, Kalp, Nirukta, Vyakaran, Jyotish),	06
3	Indian Knowledge System and Modern Science: Co-existence of Science and Spirituality in ancient India, Superior intelligence and contributions of Indian sages and scholars such as Maharshi Kanad, Aryabhata, Bhaskaracharya, Varahmihir etc, Development of science, Engineering, Technology and Architecture in ancient India.	06
4	Indian Traditional Health Care: Indian health care techniques: Yoga, Pranayam etc, Ayurveda and medical practices in Indian tradition, Yog Shastra founder Patanjali, Medical practitioners such as Charak, Sushrut	06

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	etc. and their contributions, Significance of ancient Indian health care, fitness and medical practices in modern India and world.	
5	Indian Artistic Tradition: Art and Art forms in ancient India such as painting, sculpture etc, Traditional Indian music and dance, etc.	06
6	Indian Linguistic Tradition: Ancient Indian languages and literary Heritages, Contributions of Panini, Kalidas etc. Phonology, Morphology, Syntax and Semantics.	06
7	Indian Philosophical Tradition: (Sarvadarshan) - Nyay, Vaisheshik, Sankhya, Yoga, Meemansa, Exposure to Philosophy of Charvaka, Bhagwan Mahaveer Vardhaman, Bhagwan Gautam, Sant Kabir, Guru Nanak Dev, Sant Dnyaneshwar etc, Relevance of ancient philosophy in modern India and world.	06

Term Activities:

1. Group discussions, presentations, report writing etc. on various topics in curriculum.
2. Participation in programs such as expert lectures, academic sessions, seminars etc. organized by Faculty for providing exposure to various aspects in curriculum.

Text Books:

1. Bhavan's Know India Series-1, Bhartiya Vidya Sar-1 (**AICTE approved**), edited by Shashibala, Om Vikas, and Ashok Pradhan, Bharatiya Vidya Bhavan, New Delhi, 2018.
2. Bhavan's Know India Series-1, Bhartiya Vidya Sar-2 (**AICTE approved**), edited by Shashibala, Om Vikas, and Ashok Pradhan, Bharatiya Vidya Bhavan, New Delhi, 2018.
3. Ajwani L.H., Immortal India, Vora & Co. Publishers, 1997.
4. Swami Jitatananda, Modern Physics and Vedanta, Bharatiya Vidya Bhavan, 2004.
5. Krishnamurthy V., Science and Spirituality- A Vedanta Perception, Bharatiya Vidya Bhavan, 2002.
6. Raman V.V., Glimpses of Indian Heritage, Popular Prakashan, 1993.

Reference Books:

1. Sivaramakrishnan V., Cultural Heritage of India- Course Material, Bharatiya Vidya Bhavan, Mumbai 5th edn., 2014.
2. Chatterjee S.C. and Datta D.M., An Introduction to Indian Philosophy, University of Calcutta, 1984.
3. Krishna Chaitanya, Arts of India, Abhinav Publications, 1987.
4. Jha V.N., Language, Thought and Reality.
5. Sharma D.S., The Upanishadas- An Anthology, Bharatiya Vidya Bhavan, 1989.
6. Capra F., Tao of Physics, Shambhala, 2010

Recommended NPTEL Lectures / Courses

1. Traditional Knowledge Systems and the indigenous materials; tools and techniques
NPTEL Course Lectures by Prof. Smriti Saraswat, IIT Roorkee
<https://nptel.ac.in/courses/124/107/124107006/>
2. Ayurvedic Inheritance of India NPTEL Course by IIT Madras
<https://nptel.ac.in/courses/121/106/121106003/>

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3. Indian Philosophy NPTEL Course by Dr. Satya Sundar Sethy, IIT Madras
<https://nptel.ac.in/courses/109/106/109106059/>
4. Yog Satra Online Course by Vivekananda Kendra Kanyakumari
<https://www.vrmvk.yoga/mh2020>

Sr. No.	Examination	Module
1	T – I	1, 2
2	T – II	3, 4
3	Final Examination	1 to 7

VA-BTM391 Introduction to Python Programming

Course Pre-requisites: - Higher Secondary Education or equivalent

Course Objectives:

The objective of this course is to:

- Learn capabilities of Python programming for numerical computations
- Prepare student to do engineering calculations using Python programming.
- Use Python for data analysis related to engineering applications.

Course Outcomes:

At the end of the course, the student will be able to

1. Write codes for common algorithms to do engineering computations
2. Apply features of python language to produce efficient and modular computer code
3. Debug Python code
4. Implement open source numerical libraries to build engineering applications

Course contents:

Sr.No.	Description	Duration (hrs)
1	Practical 1: Introduction to Python, variable Types, Operators and Branching	4
2	Practical 2: Development of program, Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration	4
3	Practical 3: Functions, Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Recursion on non-numerics, File operations	4
4	Practical 4: Tuples and Lists: List Operations, Mutation, Aliasing, Cloning Dictionaries: Functions as Objects, Global Variables	4
5	Practical 5: Classes and Inheritance: Object Oriented Programming, Class Instances, Methods Debugging techniques	4
6	Practical 6: Use of open source libraries: NumPy and Matplotlib	4
7	Practical 7: Writing an engineering application for data analysis	4

Term work/Journal: e-Folder based on practical work.

Recommended Books:

1. Open source documentation at <https://docs.python.org/3/library/index.html>
2. John V. Guttag, Introduction to Computation and Programming Using Python – with Application to Understanding Data, The MIT Press, 2016.
3. Nagar Sandeep. *Introduction to Python: For Scientists and Engineers*, Independently published (2016).

BS-BTM401 Statistics Probability Hypothesis Testing and Vector Calculus

Course Pre-requisites: - BS-BT101, BS-BT201

Course Objectives:

1. Introduce Statistical methods, probability distribution and testing of hypothesis.
2. Introduce Vector Integration.
3. Introduce Numerical Techniques to solve linear, non-linear and DE.

Course Outcomes:

Upon successful completion of course students will be able to

1. Solve problem in basic statistics, probability, probability distribution, testing of hypothesis.
2. Solve the problem based on vector integration.
3. Solve Linear equations, DE, Integration using numerical methods.

Course Content

Module	Details	Hours
1	Statistics: Correlation, Karl Pearson coefficient & Spearman's rank Correlation coefficient, linear regression, lines of regression.	6
2	Discrete Random Variables: Random variables, Probability distribution for discrete random variables, Expected value and Variance, Binomial Distribution and Poisson Distribution.	6
3	Continuous Random Variables: Probability Density Function for continuous random variable, Normal Distribution.	4
4	Sampling Theory: Sampling distribution. Test of Hypothesis. Level of significance, critical region. Large and small samples. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. Test for significance of the difference between sample S.D and population S.D, Test for significance of the difference between the S.D of two samples.	6
5	T-Test: Student's t-distribution and its properties. Test of significance of small samples. Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples, Chi-square distribution and its properties.	6
6	Vector Integration: Vector integrals – Line and surface integrals, Green theorem in plane, Stoke's theorem, Gauss's Divergence theorem. Applications of Vector Integrals to mechanical engineering.	7
7	Numerical Methods: Numerical solution of linear and non-linear equations Using Bisection method, False position method, Newton-Raphson method. Numerical integration using Simpson's 1/3 rd rule, Simpson's 3/8 th rule, Trapezoidal rule. Solving DE using Euler method, Runge-Kutta IVth order	7

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Reference Books:

- (1). N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2010.
- (2). B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 2000.
- (3). T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.
- (4). Murray Spiegel, “Schaum's Outline of Probability and Statistics”, 4th Edition, Tata McGraw-Hill 2012.

Sr. No.	Examination	Module
1	T – I	1 , 2 and part of 3
2	T – II	Remaining part of 3, 4 and part of module 5
3	Final exam	1 to 7

***A total of 10 tutorials to be taken batch wise covering the entire syllabus.**

PC-BTM403 Fluid Mechanics

Course Pre-requisites: BS-BT105, BS-BT106

Course Objectives:

The objective of the course is to make students familiar with the basic behavior of static and dynamic fluid so that they can use this understanding to acquire deeper knowledge of the domain and solve real-life problems.

Course Outcomes:

On successful completion of the course, students will be able

1. to define the fundamental principles of fluid mechanics and identify the basic principles behind an application.
2. to describe and explain the basic principles and related mathematical models.
3. to apply the knowledge, perform calculations and solve real-life problems.
4. to analyze a given system and recommend a better solution after its evaluation.

Course Contents:

Module	Description	Hrs.
1	Fundamental Concepts: Continuum, fluid properties - density, pressure, viscosity, surface tension, compressibility. Classification of fluid – Newtonian and Non-Newtonian, Viscous and Inviscid, Compressible and Incompressible.	04
2	Fluid Statics: Definition of body forces and surface forces, static pressure, Pascal's law, Derivation of basic hydrostatic equation, Application to manometer, Forces on submerged surfaces, Fluid in rigid body motion, Buoyancy, stability and Archimedes' Principle.	06
3	Fluid Kinematics: Velocity and approach of description- Lagrangian and Eulerian, Acceleration, Classification of flow field – one, two and three-dimensional, steady and unsteady, uniform and non-uniform, rotational and irrotational, Laminar and turbulent. Fluid element's translation, rotation and deformation, Flow patterns: streamlines, path lines and streak lines.	06
4	Fluid Dynamics: Basic flow conservation equations and method of analysis- Integral and Differential approach. Reynolds Transport Equation and its application. Navier–Stokes equations (without proof) for rectangular and cylindrical co-ordinates. Cases of exact solutions of NS equations: viscous laminar flow of a fluid through a pipe, Couette flow, Euler's equations; Bernoulli's equation and its applications. Dimensional and Model Analysis: Fundamental concepts and its application	06

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5	Turbulence and Boundary Layer: Reynolds number and its significance in flow characterization. Concept of turbulence, its measurement, effect on NS equation and flow pattern. Modeling of turbulence and Turbulence models- Prandtl Mixing Length and Turbulent viscosity based models. Boundary layer and its measurement, its development flat plate with zero pressure gradient Boundary layer equations its solution –Blasius solution (without derivation), Von-Karman momentum integral approach. Description of turbulent velocity profile in boundary layer- viscous, buffer and turbulent.	08
6	Internal and External Flows: Internal - Laminar flow through pipes and ducts. Deriving velocity profile using NS equation and developing expression to compute other quantities- flow rate, pressure drop, shear stress, friction factor etc. Head losses- major and minor losses, Moody's diagram, Flow through branched pipes. External – Flow over immersed bodies: Plate, Sphere, Cylinder and other objects. Concept of drag and lift, flow separation and methods to control, Streamlined and bluff bodies.	06
7	Compressible Flow: Characteristics of compressible flow, Concept of speed of sound, pressure, stagnation and sonic properties, Effect of area variation on flow properties in isentropic flow, Isentropic flow through converging nozzle – critical pressure ratio and choked flow, Using gas tables to solve basic problems.	06

Recommended Books:

1. Fox and McDonald, "*Introduction to Fluid Mechanics*", John Wiley & Sons, 8ed.
2. Frank M. White, "*Fluid Mechanics*", McGraw Hill, 7ed.
3. Streeter V L and Wylie E B, "*Fluid Mechanics*", McGraw Hill, 8ed.
4. Munson B R and Huebsch W W, "*Fundamentals of Fluid Mechanics*", Wiley, 7ed.
5. Shaughnessy E J, "*Introduction to Fluid Mechanics*", Oxford University Press, 1ed.
6. Yunus Cengel and John Cimbala, "*Fluid Mechanics*", Tata McGraw Hill. 1ed.
7. Potter M C, "*Mechanics of Fluids*", Cengage Learning; 4 ed

Sr. No.	Examination	Module
1	T – I	1, 2
2	T – II	3, 4
3	Final exam	1 to 7

PC-BTM404 Mechanical Engineering Measurements**Course Pre-requisites: - BS-BT105, BS-BT205****Course Objectives:**

The objective of the course is to impart fundamental knowledge of mechanical measurement techniques and data analysis with its application to the measurement of several mechanical engineering quantities.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe overall methodology of measurement and fundamental concepts of experimental data analysis
2. To define different types of errors and to discuss uncertainty analysis
3. To examine common techniques used for measurement of mechanical quantities
4. To select measurement system for engineering applications

Course contents:

Module No.	Description	Duration (hrs.)
1	Introduction: Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, Modifying and Interfering. Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Precision, Threshold, Resolution, Reproducibility, Hysteresis, Drift, Range and Span etc. Dynamic characteristics: Order of instruments, dynamic behavior under standard inputs and key terminology.	04
2	Errors in measurement and data analysis: Types of errors, factor influencing measurement, methods of elimination, Probable errors, Uncertainty and Uncertainty analysis Statistical analysis of data: arithmetic mean, deviation, average deviation, standard deviation, variance.	04
3	Displacement measurement: Transducers for displacement measurement – Potentiometers, LVDT, Capacitance type, Digital transducers (Optical Encoder), Nozzle Flapper transducer. Strain measurement: Theory of strain gauges, gauge factor, Temperature compensation, Bridge circuit, Orientation of strain gauges for force and torque measurement, Strain gauge based load cells and torque sensors.	05
4	Angular velocity measurement: Tachometers, Tachogenerators, Digital tachometers, Stroboscopic methods. Acceleration measurement: Theory of accelerometers and vibrometers, Practical accelerometers, strain gauge based and piezoelectric accelerometers.	05
5	Pressure measurement: Pressure standards, Elastic pressure transducers viz. Bourdon Tubes, Diaphragms, Bellows and Piezoelectric pressure sensors, High pressure measurement: Bridgman gauges. Calibration of pressure sensors. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Pirani gauge, Ionization gauge, Thermal conductivity gauge, Knudsen gauge etc.	06
6	Temperature measurement: Thermodynamic Temperature Scale and IPTS,	06

	Electrical methods of temperature measurement viz. Resistance Thermometers, Thermistors, Thermocouples, Pyrometers.	
7	Flow measurement: Venturimeter, Orifice meter, flow nozzles, Pitot tube, Rotameter, Hot wire Anemometers, Turbine flow meters, Laser Doppler Anemometer etc. Miscellaneous measurement: Measurement of liquid level, humidity etc. Digital Instrumentation, Data Acquisition System, Signal Conditioning systems, Op-Amplifier. Internet based measurement (Connecting Measurement system to internet).	06

Recommended Books:

1. E.O.Dobelin, "Measurement Systems (Applications and Design)", McGraw Hill.
2. A.K. Sawhney & Puneet Sawhney, "Mechanical Measurements and Instrumentation & Control", Dhanpat Rai & Co., Twelfth Edition.
3. Thomas Beckwith, N. Lewis Buck, Roy Marangoni, "Mechanical Engineering Measurement", Narosa Publishing House, Bombay.
4. B.C. Nakra and K.K. Chaudhry, "Instrumentation Measurement and Analysis", Tata McGraw Hill. Third Edition.
5. A.K. Thayal, "Instrumentation and Mechanical Measurements". Galgotia Publications Pvt. Ltd.
6. E.O. Dobelin, "Engineering Experimentation", McGraw Hills International Edition
7. J.P. Holman, "Experimental Methods for Engineers", McGraw Hills International Edition.
8. S.P. Venkateshan, "Mechanical Measurements", Ane Books, India.
9. C.S. Rangan, G.R. Sharma, V.S.V. Mani, "Instrumentation Devices and System", Tata McGraw Hill, New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Semester	1 to 7

PC-BTM406 Material Science

Pre-requisites: - BS-BT105, BS-BT106

Course Objectives:

The objective of this course is to:

Make students familiar with of mechanical, physical and chemical properties of common engineering materials- metals, ceramics, polymers and composites with rationale behind these properties and to develop good understanding of these.

Course Outcomes:

Students shall be able to

1. Explain basic concepts of materials science and metallurgy in terms of material properties at micro as well as macro scale and to discuss economic, environmental and social issues of material usage.
2. Categorize different material imperfections and apply this knowledge to explain failures.
3. Demonstrate the concept of iron-carbon equilibrium diagram & phase diagrams and understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions.
4. Describe about different types of heat treatment methods to tailor the properties of Fe-C alloys and examine properties of nonferrous, ceramic and composite materials.

Course contents:

Module No.	Description	Hours
1	Introduction: Historical perspective and Materials Science, Important Mechanical properties of Materials, Classification of materials, Advanced materials and Smart materials and their examples, Materials for Additive Manufacturing	4
2	Phase diagrams: Equilibrium phase diagrams, Alloys, substitutional and interstitial solid solutions- Phase diagrams, Kinetics of nucleation and growth, Gibbs-Phase rule, Phase transformations and TTT diagrams. Iron-carbon equilibrium diagram: Invariant Reactions, Microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron lever rule.	6
3	Atomic Arrangements: Lattice, Unit cells, Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. ASTM grain size.	6
4	Heat Treatment: Different types of heat treatment like annealing, normalizing, tempering, austempering, stress relieving etc. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening Ductile-Brittle transition: Fatigue, crack initiation and propagation, Creep, generalized creep behavior, stress-strain curves of materials.	8

5	Alloying of steel: properties of stainless steel and tool steels, merging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and copper-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys	6
6	Ceramic, Composites & Nano materials: Ceramic materials, application of ceramics, properties of ceramics, inorganic glasses. Polymers: classification of polymers, thermoplastics and mechanical properties, Elastomers, Thermosetting polymers Composites: types, characteristics and applications Introduction to Nano materials: Nano structured materials. Nano clusters & Nano crystals.	7
7	Economic, environmental and social issues of material usage: Economic considerations, Environmental and societal considerations, Recycling issues, Materials used in constructions.	5

Text Books:

1. Callister, William D., and David G. Rethwisch. Materials science and engineering: an introduction. Vol. 7. New York: Wiley, 2007.
2. Kodgire, V. D., and S. V. Kodgire. "Material science and metallurgy." Everest Publication, 2009.
3. Balasubramaniam, R. Callister's Materials Science and Engineering: Indian Adaptation (W/Cd). John Wiley & Sons, 2009.
4. V. Raghavan, "Material Science and Engineering", Prentice Hall of India Private Limited, 1999.

Reference Books:

1. Lawrence, H., and Van Vlack. "Elements of materials science and engineering." (1989).
2. Guy, Albert G. *Physical metallurgy for engineers*. Addison-Wesley Pub. Co., 1962.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

PC-BTM412 Kinematics of Machinery

Course Pre-requisites: ES-BTM104, ES-BTM204

Course Objectives

1. To provide basic concept of kinematics analysis of machines and machine members.
2. To give basic knowledge on kinematic design of machinery.
3. To understand the relationship between geometry and motion of the part of the machine.
4. To create a basic foundation for static and dynamic force analysis and ultimately for mechanical transmission system.

Course Outcome:

Upon successful completion of the course, student will be able to

1. Discuss basic concept of kinematics analysis and develop velocity and acceleration diagrams for different mechanisms.
2. Calculate Inversions of kinematic chains, special purpose mechanisms.
3. Perform kinematic analysis
4. Determine and construct gear tooth profile and discuss interference in involute gears and perform cam-follower motion analysis.

Course Contents:

Module No.	Details	Hrs.
01	Basic Kinematics: Structure, Machine, Link and its types Kinematics pair -Lower pair and higher pair, Form closed pair and force closed pairs, Based on relative motion permitted such as revolute, prismatic, cam, helical, globular. Kinematics chain and Mechanisms: Grublers criterion for movability of chains and mechanisms, Limitations of Grublers Criteria. Inversion of chain: Study of various mechanisms derived from inversions of following chains (with regard to motion of links of mechanisms, motion modification, quality of motion transmission (uniform, non-uniform, SHM, Non-SHM), limiting positions, dead positions, quick return property, applications). -- Four bar chain (Grashoffian, and non-Grashoffian), Single slider crank chain, and Double slider crank chain.	04
02	Exact Straight line generating Mechanisms – Peaucellier and Harts (Walking mechanism-Theo Jansen), Approximate straight line generating Mechanisms – Watts, Roberts, Evans and Chebyshev, Offset slider crank mechanisms, Pantograph, Hook joint single and Double Steering gear mechanisms – Ackerman, Devis.	04
03	Velocity and Acceleration Analysis of mechanisms (mechanisms up to 6 links). Velocity analysis by instantaneous center of rotation method (Graphical approach).	04
04	Velocity and acceleration analysis by relative method (Graphical approach), Position analysis of links, velocity and acceleration analysis of slider crank mechanism using complex algebra.	04

05	Cam and Follower- classification, motion analysis and plotting of displacement-time, velocity –time, jerk-time for uniform velocity, UARM, SHM & Cycloidal motion (combined motions during one stroke excluded), generation of cam profile for roller and flat face follower,	04
06	GEARS: Law of gearing, Conjugate profile and its graphic construction, Involute and cycloid gear tooth profile, Construction of involute profile, Path of contact, arc of contact, contact ratio for involutes tooth,	04
07	Interference in involutes gears. Critical Numbers of teeth for interference free motion. Methods to control interference in involutes gears, introduction to Cyclo drive for single-stage large speed reduction	04

Term Work:

1.THEORY ORIENTED:

- Assignment based on topics covered.
- MCQ based on topics mentioned in latest GATE syllabus
- ADAMS Software

2.PROBLEM ORIENTED:

A Graphic work (on half imperial drawing sheets)

(a)	Inversion of kinematic chain, limiting position and dead position	4P
(b)	Location of instant center, Velocity analysis by ICR	4P
(c)	Velocity and acceleration analysis by relative method.	4P
(d)	Construction of cam profile.	1P
(e)	Construction of x-t, v-t, a-t, curves of follower motions	1P
B Analytical / Numerical work		
1. Numerical Problems on gear		5P
2. Numerical Problems on slider crank mechanism for vel/acc. analysis		2P
3. Any two problem using computer programming. (C++/MATLAB)		2P
C. Demonstration with physical models of mechanisms		
D. Simulation of motions of mechanism using CAD package (e.g. CATIA).		

Recommended Books:

1. Rattan S.S. “*Theory of Machines*” Tata McGrahill, ed 3, 2016
2. A. Ghosh, A.K. Mallik, “*Theory of Mechanisms and Machines*”, East West Press, ed.3, 1999.
3. P.L. Ballaney, “*Theory of Machines and Mechanisms*”, Khanna Publishers, 2003.
4. Bevan Thomas, “*Theory of Machines*” 3rd edition, CBS publication.

Reference Books:

1. Rane U.S., video playlist: <https://www.youtube.com/playlist?list=PLB059985630300733>

PC-BTM415 Solid Mechanics

Course Prerequisites: PC-BTM302

Course Objectives:

The objective of this course is to present the mathematical and physical principles in understanding the linear continuum behavior of solids

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Describe stresses and strains as tensors
2. Calculate the stresses and strains in solids under different types of loading
3. Derive mathematical solutions for deformation behavior of simple geometries
4. Discuss solutions using potentials and energy methods

Course contents:

Sr.No.	Description	Duration (hrs)
1	Introduction to Cartesian tensors, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions, True stresses and strains	5
2	Strains: Concept of strain, derivation of small strain tensor and compatibility equations, measurement of strain using strain gauges and rosettes	4
3	Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Principle of superposition, Uniqueness theorem, Plane stress and plane strain problems	4
4	Introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems: Application of theory to thick cylinders, rotating discs	5
5	Torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems	4
6	Solutions using Energy methods, Strain energy, Resilience, proof Resilience, Calculation of stresses due to suddenly applied load, impact load, Strain energy stored due to shear.	3
7	Introduction to material plasticity, strain hardening, the Bauschinger Effect, concept of yield locus and yield surface, Introduction to fracture mechanics	3

Term work:

- Assignment based on above topics and seminars.
- MCQ based on topics mentioned in latest GATE syllabus
- Mini project / seminar based on course content

Recommended Books:

1. Srinath L. S. *Advanced Mechanics of Solids*, McGraw Hill (2017).
2. G. T. Mase, R. E. Smelser and G. E. Mase, *Continuum Mechanics for Engineers*, Third Edition, CRC Press (2004).
3. Schmidt R.J. and Boresi A.P. *Advanced Mechanics of Materials*, Wiley (2009).

Reference Books:

1. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International (1965).
2. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international (1969).

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Semester	1 to 7

PC-BTM453 Fluid Mechanics Laboratory

Course Prerequisites: PC-BTM403

Course Objectives:

The objective of this course is to enhance the practical knowledge and understanding of course BTM403 through live examples and by performing experiments which involves principles of fluid mechanics

Course Outcome:

On successful completion of the course, students will

1. have improved understanding of the principals of fluid mechanics.
2. lean to carryout experiment in fluid related problems and apply basic principles to solve real life problem based of fluid mechanics.
3. be able to record experimental data, its interpretation and representation.
4. be able to design simple experimental setup in fluid mechanics

Exp. No.	Details of Laboratory Experiment	Hrs.
1.	To determine specific gravity of a given liquid	02
2.	To verify Archimedes principle and to determine specific gravity of a concrete block	02
3.	To determine the coefficient of discharge of a given orifice plate	02
4.	To determine kinematic viscosity using Hagen-Poiseuille setup and prove that head loss is proportional to volume flow rate	02
5.	To determine the coefficient of discharge of a given Venturimeter	02
6.	To determine Darcy Friction factor for pipes of different diameters	02
7.	To carryout experiment on a given experimental setup to verify Bernoulli's theorem	02
8.	To determine coefficient of impact of a jet in flat and inclined plate	02
9.	Case based numerical calculations involving fundamentals of fluid mechanics	08

Recommended Books:

1. *Fluid Mechanics Laboratory Manual*, Department of Mechanical Engineering, SPCE.

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ) based on topics mentioned in latest GATE syllabus
4. Oral Examination

PC-BTM454 Mechanical Engineering Measurements Lab.

Pre-requisites: - PC-BT205

Course Objectives:

1. To impart hands on different mechanical engineering measurement system
2. To understand methodology to characterize the measurement systems and error analysis
3. To design and synthesize the measurement system

Course Outcomes:

On successful completion of the course learner should be able to

1. Calibrate the mechanical engineering measurement system.
2. Characterize measurement system and find the error and perform uncertainty analysis
3. Design measurement system
4. Synthesize measurement system/sensor

List of Experiments: Any seven experiments from the following list of experiments:

1. Calibration of pressure gauge using dead weight pressure gauge tester.
2. Calibration of load cell.
3. Calibration of strain gauges.
4. Calibration of LVDT.
5. Calibration of tachometer.
6. Calibration of accelerometer/vibrometer.
7. Calibration of flow meters.
8. Calibration of temperature sensors.
9. Time constant of thermometer.
10. Study of anemometer.
11. Study of Optical Encoders
12. Study of Smart Sensors

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Mini project on development of measurement system or characterization of sensor in group of 4 students.
4. Examination (MCQ) based on topics mentioned in latest GATE syllabus
5. Oral Examination

PC-BTM456 Material Science Laboratory

Course Pre-requisites: - PC-BT406

Course Objective:

1. To familiarize with use of optical laboratory microscope
2. To acquaint with microstructures of Materials.
3. To familiarize with microstructures of steel under different heat-treated conditions.

Course Outcomes:

Students shall be able to

1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography).
2. Interpret different phases present in different steels and cast irons.
3. Interpret different failures and dislocations in different material samples.
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel.

List of Experiments:

The laboratory work shall consist of a journal based on the below mentioned laboratory experiments/study

1. Study of Metallurgical Microscope.
2. Preparation of Specimen for microscopic examination.
3. Study of microstructure of plain carbon steels of various compositions.
4. Study of microstructure of various types of C.I.
5. Study of microstructure of various types of alloy steels.
6. Study of microstructure of non – ferrous metals and their alloys.
7. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
8. Surface hardening and study of microstructure
9. Study of I.S. codes of steels and selection procedure.
10. Study of Microstructures of Components developed by Additive Manufacturing Processes.

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. MCQ based on topics mentioned in latest GATE syllabus
4. Oral Examination

PC-BTM499 Assembly Shop Practice

Pre-requisites: - PC-BTM399

Course Objectives:

In this course the students will:

1. Learn different safety precautions to be taken during manufacturing processes.
2. Interpret job drawings, plan and execute processes and operations to produce basic components from raw material for an assembly.

Course Outcomes:

Upon successful completion of the course the student will be able to:

1. **Know** different safety precautions to be taken during manufacturing processes.
2. **Interpret** job drawings, **plan** and **execute** processes and operations to produce basic components from raw material for an assembly.

Course Contents:

Job No.	Details	Hrs.
01	<ul style="list-style-type: none">• One composite job of assembly of minimum three components produced using lathe, shaper, milling, drilling and grinding machines and involving the operations of precision turning, taper turning, taper boring, internal threading, shaping plain flat surfaces, milling, drilling, grinding etc.	18
	<ul style="list-style-type: none">• One job on each CNC Machines - CNC Lathe and CNC Milling	6
02	One composite job on open ended engineering problem	4

Reference Books:

1. W. A. J. Chapman, “*Workshop Technology- Part I, II and III*”, Edward Arnold.
2. G. Boothroyd & W.A. Knight, “*Fundamental of Machining and Machine Tools*, third edition”, CRC.
3. S K & A K Hajra Choudhary, “*Workshop Technology, Vol. I, II*”, Media promoters and publishers pvt. Limited, 2007.

VA-BTM491 COBOTS – Collaborative Robots

Course Prerequisites: Manufacturing science

Course Objectives:

The objective of this course is to present introduction to collaborative robots (COBOTS)

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Describe role of COBOTS in manufacturing
2. Explain safety aspects of COBOTS during interaction with humans
3. Discuss standards and guidelines for COBOTS
4. Explain future trends in collaborative robots technology

Course contents:

Sr.No.	Description	Duration (hrs)
1	History and development of collaborative robots, comparison with conventional robots	4
2	Safety aspects of COBOTS during its interaction with humans	4
3	Role of COBOTS in manufacturing processes and other areas of application	4
4	Study of different types of industrial collaborative robots – case studies	4
5	Programming, setup and flexible automation using COBOTS	4
6	Operational aspects of COBOTS – hand guiding, power and force limiting, safety monitored stops, speed and separation monitoring	4
7	Emerging trends in development of COBOTS	4

Term work:

- Assignment based on above topics and seminars.
- Case studies and presentations

Recommended Books:

1. Matthew Wilton, *Essential Guide To Risk Assessment for Collaborative Robots* (2018)
2. Michal Gurgul, *Industrial robots and COBOTS* (2018)
3. Research articles shared during coursework

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Semester	1 to 7